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The Editor's Page

THE Institute's Research Committee is deeply indebted and extends its thanks to those members, and others who participated in the wear testing conference in March, who have kindly co-operated in furnishing samples and data of fabrics and garments that show results of actual wear. Correlation tests are now in progress at the Bureau of Standards and the Massachusetts Institute of Technology. Additional samples could be used.

Textile Research at a Premium

IN the April and May issues of this magazine members and subscribers, having November and December, 1933, issues of *Textile Research,* were offered fifty cents each for any number up to 50 copies. The fact that none of them have taken advantage of this offer, nor have volunteered to help us in making available to new members these issues which are out of print, apparently indicates that, unlike the dollar, back numbers are on a premium basis. This type of hoarding is appreciated by the editors, and will encourage them not only to maintain past standards, but to improve them.

The Thermodynamics of Swelling

By RAYMOND L. STEINBERGER*

An attempt has been made to bring together from the literature the important results of studies on swelling processes which have been made from the thermodynamic point of view. The quantities involved are swelling pressure, free energy, heat of swelling entropy and volume contraction. Each is related either to the vapor pressure of the gel by equations derived by simple thermodynamic methods, or is related to the water concentration of the gel by empirical formulas. A comparison of swelling pressure with osmotic pressure is made and it is demonstrated that both arise in the same fundamental process. Entropy changes with swelling are related to the distribution of the water molecules within the gel. Volume contraction is ascribed to the dissociation of ordinary water, which has a complex molecule, to the simple monomolecular form in the gel. Since swelling and capillarity are intimately related phenomena the important points of contact of the two are discussed.

SWELLING bodies exist in two general classes. One is characterized by limited swelling wherein the amount of liquid or vapor imbibed reaches a definite maximum regardless of the amount available. In the other class no such limit is observed; the swelling is simply a preliminary step in the process of complete dispersion of the body to a molecular or colloidal solution. Materials of great practical importance such as cellulose, wood, casein, and textile fibres, etc., when the swelling medium is water, belong to the limited swelling class. Each substance may, however, exhibit unlimited swelling in the proper reagent. Swelling is thus a relative process. For simplicity the following discussion will be restricted to limited swelling processes where the swelling medium is water, except when the contrary is specifically stated, and the word gel will be used instead of "swelling body."

* Dr. Steinberger is a Senior Fellow of the Textile Foundation working under the direction of Prof. P. W. Bridgman, Harvard University, Cambridge, Mass.

Studies of swelling phenomena are difficult to collect from the literature because of the importance of the phenomena in biological processes. Important experimental results are scattered throughout the botanical, zoological, and medical literature in addition to the journals of physics and physical chemistry. J. R. Katz [1] has unified the subject up to 1925 in a comprehensive treatment published in the Ergebnisse der Exakten Naturwissenschaften. The same author has also written a review of the subject in a recent number of the Faraday Society Transactions.[2]

Thermodynamic methods can be used in the development of relations between those properties of gels which are continuous functions of the degree of swelling. The point of view of Katz and earlier investigators was that the thermodynamics of mixtures and true solutions as developed in the treatises of Nernst [3] and Planck [4] are applicable. The development of the vapor pressure relation for swelling bodies on such assumptions leads to a formula identical with that for osmotic pressure. J. J. Bikerman [5] has recently discussed E. Posnjak's [6] experimental values of swelling pressure which do not at all follow the simple van't Hoff osmotic pressure formula. The question now arises: which of the two pressure phenomena should be considered the more fundamental, swelling pressure or osmotic pressure? The old treatment of osmotic pressure as a true gas pressure of the dissolved substance obscures the real mechanism. Van Laar [7] has shown that osmotic pressure should be treated by the thermodynamic potential method rather than through the application of the perfect gas law. Von H. Hulshof, whose work will be discussed later, has shown from thermodynamic potential treatment that osmotic and swelling pressures have the same origin and that the latter is the more fundamental physical phenomenon. Osmotic pressure is nothing but swelling pressure made evident by the external device of a semipermeable membrane. In a limited swelling body, the body itself acts as its own semipermeable membrane. In unlimited swelling bodies the "membrane" is unable to resist the solvating action of the dispersion medium, and final disintegration to a homogeneous molecular or colloidal solution is the result.

From the point of view of this discussion seven magnitudes

are of prime importance in understanding the thermodynamic behavior of gels: They are (1) the water concentration (i) of the gel expressed in grams of water per gram of dry gel; (2) the vapor pressure (p) of the swollen gel; (3) swelling pressure (P); (4) free energy (Ψ) of swelling; (5) heat of swelling (W); (6) entropy changes (S) accompanying swelling; and (7) volume contraction (C). The water concentration (i) is the single independent variable in terms of which all the other quantities may be expressed. The vapor pressure p is related to i by the so-called swelling isotherm. Each of the remaining quantities are either derived from p by various formulas or are empirically stated in terms of i.

Swelling Pressure

If, while a gel is imbibing water, volume increase is prevented by some mechanical restraint, such as a rigid cylinder equipped with a piston, a pressure of considerable magnitude will be developed. A relation between this swelling pressure and the vapor pressure of the gel can be set up as follows[8]: As indicated in Fig. 1, let there be two identical cylinders, each

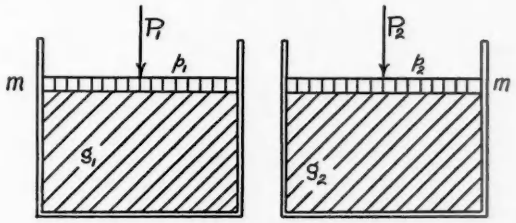

FIG. 1

filled with a large quantity of the same kind of gel. The pistons are permeable only to water either in the liquid or vapor states. Let the two gels g_1 and g_2 differ slightly in water content (i). Then g_1 exists under a swelling pressure P_1 and a water vapor pressure p_1. The corresponding quantities for the more swollen gel (g_2) are P_2 and p_2. It is assumed here that the gel itself has a negligible vapor pressure. Let a small amount of water, dm mols, be pressed out of g_1. The corresponding decrease in volume of g_1 will be dV. The work done on g_1 will be $-P_1dV$. Let the same dm mols of water flow into g_2 through its permeable piston. Gel g_2 will increase in volume the same amount that g_1 decreases and the work obtainable from g_2 will be $+P_2dV$. This assumes that the dV/dm is the same in both gels, g_1 and g_2, or, in other words, the volume change of the gel per mol of added water is the same in both gels. This is not strictly

true, but the difference is of the second order and may therefore be neglected when, as in the following discussion, g_1 and g_2 are made to differ infinitesimally in water content. The net work done by the system comprising the two gels will then be

$$dV\ (P_2 - P_1)$$

The transport of water is carried out isothermally and reversibly. The reverse transport of dm mols of water can however be made by isothermal distillation. The work done by the system in transporting dm mols of water from vapor pressure p_2 to p_1 is

$$+ dm \int_{p_2}^{p_1} pdV = - dm\ RT\ \log\ p_1/p_2$$

assuming that the perfect gas law

$$pv = RT$$

holds for the water vapor above each piston or in contact with each gel. Both processes are carried out isothermally and reversibly. The system is restored identically to its initial condition. The sum of the two amounts of work must be zero, otherwise the system could perform work at the expense of the heat of its surroundings in violation of the Second Law of thermodynamics by a proper choice of the direction in which the cycle is traced. Therefore.

$$dV\ (P_2 - P_1) - dm\ RT\ \log\ p_1/p_2 = 0$$

$$dV/dm = (RT\ \log\ p_1/p_2)/(P_2 - P_1)$$

The volume change (dV) of the swollen gel is not precisely equal to the volume of the dm mols of water pressed out. There is a measurable volume contraction with swelling. The volume of the swollen gel is slightly less than the sum of the volumes of the dry gel and the water. If V is the volume of the swollen gel and V_w is the volume of the water before it is taken up by the gel

$$V = V_g + V_w - C$$

where C is the total volume contraction of the water when it enters the dry gel and V_g is the volume of the dry gel. Then, since V_g is constant, $dV_g = 0$; *i.e.*, there is no change in volume of the pure gel constituent with swelling.

$$\begin{aligned} dV/dm &= dV_w/dm - dC/dm \\ &= Mv - Me \\ &= Mv(1 - e) \end{aligned}$$

where M is the molecular weight, and v is the specific volume of free water. The amount one gram of water shrinks is e, and e is the fractional amount the specific volume decreases when imbibed by the gel. The swelling pressure relation then becomes

$$Mv(1 - e)/RT = (\log\ p_1/p_2)/(P_2 - P_1)$$

The left side of the equation is a positive number. Therefore the gel under the greater external pressure has the smaller vapor pressure.

A relation between swelling pressure (P) and vapor pressure (p) in a single gel-water system would be more useful than the preceding difference equation. Such an expression follows at once if we consider, instead of the finite difference between g_1 and g_2, an infinitesimal difference in water content so that we can write

$$P_2 - P_1 = dP$$
$$p_2 - p_1 = dp$$

Then

$$Mv(1 - e)/RT = -(1/dP) \log (1 + dp/p_2)$$
$$= -(1/p_2)\, dp/dP$$

In the limit as dp is made smaller

$$p_1 = p_2 = p$$

Integration gives

$$P = -(RT \log p)/Mv(1 - e) + \text{constant}$$

When the swelling is so complete that p is equal to the saturation pressure (p_s) of water, the swelling pressure is zero and the constant can be determined. Then P can be expressed as a function of the ratio h of the vapor pressure (p) of the gel to that of pure water (p_s) at the same temperature. That is

$$P = -(RT \log h)/Mv(1 - e)$$

The quantity e, which is the shrinkage of specific volume of the water averaged over all the water in the gel, is negligibly small compared with unity for all gels not in a state of extreme dryness. It does, however, reach the surprising value of nearly 30% as complete dryness is approached. In the following discussion of swelling pressure, e will be considered zero. Therefore we have

$$P = -(RT \log h)/Mv \qquad (1)$$

The presence of the quantity e puts a limit on the validity of equation (1) when very dry gels are considered. Note that the relation involves no intrinsic constant of the solid gel constituent. The quantities R, M, v, p_s all refer solely to the mobile constituent pure water. The pressures P and p refer to the system, gel plus water.

It is obvious from common experience that forces of considerable magnitude are involved in the process of swelling. The shrinkage of moistened rope, or other spun textile products, is, paradoxically, a manifestation of powerful swelling forces. Because of the artificial spiral structure of the rope, lateral swelling increases the diameter of the helix upon which each single fibre lies, but since the swelling of natural fibres, which have a parallel oriented crystal structure, is not isotropic, being greater in a direction normal to the fibre axis than in one parallel thereto, the spiral length of each helix does not change much. The transverse swelling of the fibres is accompanied by axial shrinkage of each helix and the resultant is an appreciable shrinkage of the rope as a whole.

To fix the ideas of magnitude, a numerical computation for swelling pressure, with water as the swelling medium, will be given using equation (1) at a temperature of 17° C:

R = 0.082 liter atmospheres per degree per mol.
T = 290° K.
M = 18, the molecular weight of water
V = 0.001 liters, the specific volume of water

$$P = -\frac{0.082 \times 290}{18 \times 0.001} \log (h)$$

$$= -3042 \log_{10} (h)$$

Values of P for several relative humidities (h) are given in the following table:

Relative vapor pressure	*Swelling pressures in atm. or appx. in kg/cm²*
h	P
0.95	67.9
.60	674.
.30	1588.
.10	3042.
.02	5170.

The swelling pressure of a gel exposed to a relative humidity of 60%, which is a reasonable value for summer humidities, is 674 atmospheres. It is not correct to say that the body exists under a pressure of 674 atmospheres nor is the imbibed water under a similar pressure. Equation (1) merely states that P is the minimum pressure necessary to press water out of the gel. Swelling pressure appears only if the gel is subjected to a mechanical constraint which prevents volume increase as water is absorbed. In the preceding and following discussion equilibrium conditions are implied, otherwise simple thermodynamic treatment would not apply.

It is difficult to measure swelling pressures at medium and high states of dryness because of the limits imposed by practical semipermeable membranes which must be mechanically strong enough to support the pressure and also must not become permeable to the gel at high pressures. Von Terzaghi and Hill[9] measured the swelling pressure of gelatin in water at h = 0.964 and found that, at a concentration of 0.8g dry gel per gram of swollen gel, the pressure was 32 kg/cm² while equation (1) gives more than twice as much, or 70 kg/cm². Rubber, swollen in benzol and in chloroform, gives better agreement. The discrepancy with water swelling, as suggested by Katz, may be due to the fact that ordinary liquid water does not have the simple monomolecular form of its vapor, but associates in aggregates of two or more molecules, while benzol and chloroform do not so associate. The molecular association of water is accompanied by an increase in specific volume. To take association into account for the high range of h here involved, the quantity e should be retained in equation (1) but with a positive sign representing an *increase* in specific volume of water imbibed. Thus, over the range of moisture content from extreme dryness to saturation, e changes from a negative to a positive fraction with a zero value somewhere

in the intermediate vapor pressure range. Within the very dry gel the molecular association of water would be less than in normal liquid water and in a very wet gel the molecular association would be greater. It is, however, difficult to see how association could give an increase in specific volume of over 100%, which would be necessary to make the computed pressure agree with the 32 kg/cm² observed by von Terzaghi and Hill. Other effects which the pressure relation does not take into consideration must be present.

The thermodynamic derivation of equation (1) tacitly assumes that the gel is a perfectly homogeneous system like a true solution. In fact the equation follows at once from the expression for the free energy of mixing of two perfectly miscible liquids, as deduced by Kirchhoff, when the vapor pressure of one constituent is negligible. Gels are certainly not homogeneous systems. In the swollen state they are aggregates of solid particles separated by liquid films of various thicknesses. In the concentrated (dry) condition gels are definitely solid bodies, such as casein, cellulose or dry gelatin. It is not to be expected that relations deduced for homogeneous mixtures should hold very precisely for condensed systems such as swollen gels.

Swelling Pressure and Osmotic Pressure

From the thermodynamic point of view, swelling pressure and osmotic pressure are very much the same. In both, pressure is a consequence of the fact that one component can move throughout the whole system, while the other must remain in a limited part of it. It is not important whether this is realized with the help of a semipermeable membrane or not. In dilute dispersion, swelling bodies exhibit osmotic pressure which is related to the vapor pressures of the solution and of the solvent by an equation precisely the same as (1). In fact, the method used for deriving (1) is precisely applicable for the osmotic relation

$$P = -(RT \log p_L/p_s)/MV_s$$

where p_s is the saturated vapor pressure of the pure solvent and p_L is the vapor pressure of the solution. As in the swelling pressure relation M and V_s are the molecular weight and specific volume of the pure dispersion medium. The constants of the dispersed phase do not enter. From the similarity of the two formulas it has often been stated that swelling and osmotic pressures have an identical origin. This is apparently denied by the experimental evidence, but when we come to consider Hulshof's work it will be evident that swelling and osmotic pressures are external manifestations of one fundamental phenomenon. The experimentally established van't Hoff formula for osmotic pressure states that

$$P = RT(C_s)$$

The pressure in atmospheres is directly proportional to the concentration C_s of the dissolved substance, expressed in mols per liter of pure solvent, and R is the gas constant in liter atmospheres. The volume of solvent at the disposal of each mol of solute is the reciprocal of C_s and, therefore,

$$PV = RT$$

This is the equation of state for a perfect gas. Because of this simple relation, which is really accidental, it is often erroneously stated that the dis-

solved particles exist in the gaseous state and occupy the total volume of the solvent.

Osmotic pressure is proportional to the first power of the concentration, while swelling pressure is approximately proportional to the third power of the concentration for many swelling systems. The empirical relation

$$P = P_o\ C_o^n$$

was found by Posnjak.[6] For gelatin in water and rubber in eleven organic liquids the exponent (n) is approximately equal to 3. The concentration C_o is expressed as grams of dry substance per c.c. of swollen gel. Bikerman [5] has explained the difference in the two empirical relations and has shown swelling and osmotic pressure to be the same phenomenon acting in two widely separated ranges of concentration. Osmotic pressure is characteristic of true solutions in the dilute condition where the particles of the disperse phase are so greatly separated that their mutual force fields have point origins. That is, presuming that the force between two particles of the disperse phase falls rapidly with the separation, the terms of the force expression which depend on the extension or size of the particles are negligible compared with the terms depending solely on the separation. In a gel the particles of the disperse phase, even in the strongly swollen condition, are enormously more closely packed than in a dilute solution. The force depending on the size of the particles is no longer negligible.

Writing the van't Hoff equation in terms of single dissolved molecules, we have

$$P = kT/v$$

where k is the gas constant per molecule, and v is the volume of the solvent at the disposal of each disperse molecule. For the simplest possible treatment, consider the dissolved molecules in a simple cubic distribution with each a center of force acting on the solvent and the force diminishing rapidly with distance from each dissolved molecule. One unit cell (of volume v) of the lattice will be at the disposal of each dissolved molecule. The point of minimum force field will be the center of the cubic cell at a distance L from the nearest dissolved molecules, where L is the half diagonal of the cubic cell. Therefore

$$v = \frac{8L^3}{3\sqrt{3}}$$

The pressure then may be written

$$P = \frac{3kT\sqrt{3}}{8L^3} \qquad (2)$$

The osmotic pressure is inversely proportional to the third power of the maximum separation of the disperse phase particles. The force origin are points.

In many gels it has been shown that the micelles are flat bodies. For a rough approximation consider the flat and relatively thin micelles arranged parallel to each other and separated by a liquid film of average thickness 2L. Then the volume of liquid associated with each micelle will be equal to Ls, where s is the total surface of one micelle. The volume of liquid per

gram of dry gel will be

$$V = LS$$

where S is the specific surface of the dry gel per gram. In the derivation of the van't Hoff osmotic pressure formula it is assumed that the dilution is so great that the volume of the solute is negligible compared with that of the solution. In the gel consisting of thin micelles the swelling will be considered so great that the total volume of the micelles is small compared with the total volume of the gel, so that V is approximately the volume of the solution per gram of dry gel. Then

$$L = V/S$$

$$= 1/cS$$

where c is the concentration of the gel in grams of dry gel per unit volume of swollen gel. If the same law of force holds in the gel as in the dilute solution the value of L may be put into the osmotic pressure equation and we have

$$P = \frac{\sqrt{3}\ k\ T}{8L^3}$$

$$= \frac{\sqrt{3}}{8} k\ T\ c^3\ S^3$$

The separation of force origins in both cases is 2L, that is, in gel and solution. The swelling pressure thus is proportional to the third power of the concentration in agreement with Posnjak's experimental results. It may well be that the intermediate condition exists where the pressure varies as the second power of the concentration but such mixtures have so far not been discovered. The disperse particles would have to be linear elements of small width and thickness compared with their length. The long principal valence chain molecules of the high polymers may possibly show this behavior if they could be molecularly dispersed without breaking down the chains too drastically. Equation (2) embraces osmotic as well as swelling pressure and is thus more general than the van't Hoff relation. Osmotic pressure so expressed loses formal identity with the gas law, which is really an advantage, for futile attacks on the problems of osmosis have been made from the point of view that the disperse phase in a dilute solution is a gas occupying the volume of the solvent.

Free Energy of Swelling

A study of free energy of swelling is important for it leads to a knowledge of entropy changes, and, also, has biological interest for it leads to interesting conclusions concerning the working efficiency of muscles which are a class of limited swelling bodies. The free energy associated with a change in a system of bodies is that part of the total energy change which can be converted into external work. In the swelling pressure equation (1), P and h are functions of (i), the water content of the gel

$$P\ (i)\ v = -(RT/M)\ \log\ p(i)/p_s$$

Either side of the equation may be used as an expression for the change in free energy, ψ (i), of a large quantity of gel of water content (i), when one additional gram of water is added

$$\psi \text{ (i)} = P(i)v$$

$$\psi \text{ (i)} = -(RT/M) \log p(i)/p_s$$

The free energy is here expressed per gram of water and may be written as a function of (i), for the amount of swollen gel is assumed so large that (i) is not appreciably changed by the addition or removal of one gram of water. By the first expression, the free energy can be directly determined by a measurement of swelling pressure. The fact that volumes are not strictly additive is neglected. The second expression gives ψ (i) indirectly from the vapor pressure vs. concentration relation (*i.e.*, from the swelling isothermals), and is the Kirchhoff relation for free energy of mixing of two substances where one has a negligible vapor pressure. The swelling isothermals (p versus i at constant temperature) have been determined by Katz [10] and by Fricke and Lüke [11] for several gels. The free energy, ψ(i), computed from the isothermals was then compared with the corresponding heat developed per gram of water added when no external work was done. The results of the comparison will be discussed after swelling heat is considered.

Heat of Swelling

When one gram of perfectly dry gel absorbs i grams of water under conditions where negligible external work is done, an amount of heat W(i) is developed. This is the integral heat of swelling, or the heat of mixture of gel and water, and of course is a function of (i), the amount of water added to the gram of dry gel. The direct addition of (i) grams of water to each gram of perfectly dry gel, and the simultaneous measurement of the heat W(i) developed, would be experimentally very difficult. Easier but less direct methods are used. Katz proceeded as follows: Two gel specimens were prepared, one of arbitrary but measurable water content (i); the other thoroughly dry. Each gel was then immersed in the water of a calorimeter so that each became saturated, and the accompanying heat development was measured. The dry specimen of course develops the greater amount of heat per gram of dry gel. The difference in heats developed is the integral heat W(i) of formation of the gel of water content (i) per gram of dry gel, from the dry gel and free water. The relation between W(i) and (i) can then be determined by repeating the experiment with gels of various water contents. The W(i) curve rises at first rapidly with (i) and then approaches asymptotically the saturation value W_s. Because of the slow attainment of saturation the last units of heat are developed very slowly and for accurate results an ice calorimeter should be used. Katz [10] found that W(i) for cellulose, casein, and nuklein is well represented by the empirical relation

$$W(i) = \frac{A\ i}{B + i}$$

which is the form discovered by J. Thomsen [3] for the heat of mixing of

sulfuric acid and water. A and B are constants depending on the substances involved.

Before the free energy and heat of swelling can be compared it is essential that the two magnitudes refer the same amounts of reacting substance. As defined above $\psi(i)$ refers to the absorption of one gram of water by a large quantity of swollen gel, while $W(i)$ is the heat of mixing one gram of dry gel with (i) grams of water. If the water concentration (i) is changed by the amount (Δi) solely by a change in total water content M while the total amount of gel G remains fixed

$$\Delta i = \Delta M/G$$

The ratio of the corresponding change in integral heat $W(i)$ to Δi is

$$[W(i + \Delta i) - W(i)]/\Delta i$$

which in the limit as Δi decreases is $w(i)$ the differential heat of swelling, or the rate of change of $W(i)$ with (i). The quantity Δi may be made to approach zero either by making ΔM decrease, or by choosing a very large amount of swollen gel while ΔM is fixed at one gram. We can thus say that $w(i)$ is the heat developed by a very large amount of gel of swelling degree (i) when it absorbs one additional gram of water. Thus $w(i)$ and ψ (i) refer to the same amount of reacting substance. The most interesting value of $w(i)$ is the limit as (i) approaches zero. It is the initial differential heat of swelling, expressing the heat developed when one gram of water is added to a very large quantity of perfectly dry gel. Since

$$w(i) = dW(i)/di$$

and $W(i)$ is given by Katz's empirical relation

$$W(i) = Ai/B + i$$

$$w(i) = AB/(B + i)^2$$

and as the water concentration (i) approaches zero the limit of $w(i)$ is

$$w(o) = A/B$$

Katz [10] has determined $w(o)$ for a series of six gels and found that it varies with the kind of gel between 250 and 420 calories per gram of water, with 390 calories for cellulose. Near $i = o$ the adsorption spots in the gel are so sparsely populated with water molecules that there is no mutual interference. 390 calories divided by the number of water molecules per gram measures the energy (4.9×10^{-13} ergs per molecule) binding an isolated water molecule to the surface of a cellulose micelle undisturbed by neighboring water molecules. This is not greatly different from the energy binding water to concentrated sulfuric acid. Very dry cellulose, like sulfuric acid, could be used as a drying agent but would probably not be very efficient because of rapid saturation.

The value of $w(o)$ for sulfuric acid-water mixture can be obtained from Thomsen's empirical formula, for the integral heat of mixing

$$W(i) = \frac{17{,}860i}{1.8 + i}$$

where W(i) is the heat developed when one mol of H_2SO_4 is mixed with (i) mols of water

$$w(o) = 17860/1.8$$
$$= 9{,}920 \text{ cal. per mol of water}$$
$$= 551 \text{ cal. per gram of water}$$

This is surprisingly close to the value for cellulose. For ethyl alcohol-water mixture w(o) is about 15 cal. per gram. of water. The heat of formation of sulfuric acid is 2000 cal./gram. This is only 3.6 times w(o) as given above. The energy with which the principal valence forces hold unit mass of sulfuric acid together is only 3.6 times the energy with which unit mass of water is held in a large quantity of concentrated acid.

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(*To be continued*)

The Microbiology of Textile Fibres

I. Cotton Fibre

By BRYCE PRINDLE*

(*Continued from Vol. IV, No. 9.*)

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Various classes of substances (*e.g.* nitroso-compounds, quinine, aldehydes, salts of heavy metals, hydroxylamine hydrochloride, aliphatic alcohols, benzylalcohol, phenol, chlorophenols, quinol, and toluquinol were tested upon cultures of *B. pyocyanous* and *B. coli.* A marked difference in the germicidal power of these substances was observed and they varied in their specificity.

Some of the compounds used in these experiments show very high phenol coefficients and might be useful in textile work.

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A general textbook covering the physical, microscopical, and chemical properties of all of the textile fibres. Good reference.

(29) THAYSEN, A. C. "THE EFFECT OF THE ACTION OF MICROÖRGANISMS ON FIBRES AND FABRICS." *J. Soc. Dyers and Col. 40,* 101–4 (1924); *Chem. Abs. 18,* 2080.

Thaysen presents an interesting non technical paper on the subject of mildew in cellulose fibres. Destruction of the non-lignin encrusted fibres occurs in the presence of more than about 10% of moisture and is due to both molds and bacteria.

The cellulose is transformed first into glucose and then into its oxidation products. The first step in the degradation of the cellulose is a hydration. Attacked fibres are more soluble than normal fibres in carbon bisulphide—alkali mixture. The swelling test is useful in determining the percentage of fibres damaged.

"Felting" and "heart damage" in bales are discussed. Both are of microbic origin and occur most frequently in Indian cotton. Resistance to mildew varies in different types of cotton fibre.

Preventative measures suggested are: use of starch substitute in sizing; elimination of moisture; development of resistant fibres; development of treatments such as acetylation of fibres.

* Mr. Prindle is a Junior Fellow of the Textile Foundation working under the direction of Dr. Samuel C. Prescott, Massachusetts Institute of Technology, Cambridge, Mass.

(30) THAYSEN, A. C. and H. J. BUNKER. "STUDIES OF THE BACTERIAL DECAY OF TEXTILE FIBRES. VARIATIONS IN THE RESISTANCE OF COTTONS OF DIFFERENT ORIGINS TO DESTRUCTION BY MICROÖRGANISMS." *Biochem. J. 18*, 140–146 (1924).

Using the swelling test of Fleming and Thaysen, *Biochem. J. 15*, 407 (1921), it is shown that fibres of different origins show variance in their resistance to attack by microörganisms. Since the resistance disappears when resistant strains are grown in countries producing strains of low resistance it is concluded that they are adversely affected by soil or climatic conditions.

Flax fibres exhibit differences in behavior similar to cotton.

The rate of deterioration of hemp and jute fibres cannot be followed by use of the swelling test.

(31) BRIGHT, T. B. "METHODS OF EXAMINATION OF MILDEWED COTTON MATERIAL." *J. Roy. Mic. Soc.* 141–144 (1925). Abs. *J. Soc. Chem. Ind. 44*, Abs. 667 (1925).

Current practice in the microscopical detection of fungi in cotton material is briefly referred to, and particulars are given of improvements in the technique of the method. Canada balsam is used in place of lactophenol as mounting medium, Picronigrosine is used instead of Cotton Blue for mounting, and the specimen is illuminated by light transmitted by a green filter from a "Pointolite" lamp. In the majority of cases a 2/3 in. objective then enables the presence of the fungi to be detected.

(32) BRITISH DYESTUFFS CORP. "PROTECTION OF COTTON AND OTHER TEXTILE OR LIKE MATERIALS FROM MILDEW." Eng. Pat. No. 259,690 (1925). Abs. *Brit. Chem. Abs.* B 1009 (1926).

The development of mildew on cotton and other textile materials including paper and leather is prevented by impregnating the material with a 0.1–1% solution of an alkali salt of a halogenated phenol containing more than two atoms of halogen in the molecule, e.g., trichloro- or tribromophenol. The halogenated phenol compound may be applied by spraying or may be added to the dye bath or, in the case of artificial silk, to the spinning solution or in the case of paper to the beaten pulp or the size.

(33) BURNS, A. C. "THE BACTERIAL DETERIORATION OF COTTON DURING DAMP STORAGE." *J. T. I. 16*, T185–96 (1925).

Ginned and unginned samples of cotton were stored under varying conditions of temperature and moisture. The swelling test of Fleming and Thaysen was used as a criterion of spoilage and observations at frequent intervals lead to several conclusions. Infection of the fibre is to be sought for and controlled in the unginned rather than the ginned cotton. Exposure to dampness prior to ginning makes the fibre less resistant to spoilage by bacteria and fungi than when dryness is maintained. Ventilation and sun drying aid in preservation. "Damping" of cotton prior to baling is not recommended.

(34) DEPT. OF SCIENTIFIC AND INDUSTRIAL RESEARCH: FIRST REPORT OF THE FABRICS COÖRDINATING RESEARCH COMMITTEE. H. M. Stationery Office, London, England (1925).

A review of published and unpublished works on textile fabrics prior to 1925 covering the deterioration of fabrics by light and microörganisms,

the mechanical testing of fabrics, the fireproofing of fabrics and a report upon weathering of specially treated materials.

Appendix II. Deterioration of Fabrics by Microörganisms. A general review of the most important literature on the subject.

Appendix V. Summary of report to the war office committee on tentage and textiles on specially treated linen and cotton duck exposed under different climatic conditions.

Samples of cotton and linen duck were exposed at twelve stations throughout the British Empire and in the following positions: (1) Facing sun. (2) Facing away from sun. (3) Facing ground. (4) In storage.

Of these it was noted that those facing the sun showed greatest deterioration. Molds and bacteria were demonstrated microscopically. Untreated linen was observed to deteriorate faster than untreated cotton.

The use of some preservatives was quite effective but others had little effect.

The most frequently occurring organism was a brown mold, the hyphae of which pierced the filaments of the canvas. It was isolated and inoculated onto treated materials. The results of this experiment are summarized in the following table:

No. of Specimen	*Treatment*	*Remarks*
2, 26	Cuprammonium	Almost complete inhibition
22	Piece-dyed olive green	Slight development
51, 52	Cutch, yarn-dyed	Good growth on surface
10, 9	Cuprammonium	Good growth
33	"	Poor growth on surface
1	Wax	Good growth

Seven types of bacteria were isolated from damaged areas. Of these a few were facultative anaerobes. When these were sown on cuprammonium, and olive drab dyed pieces of duck the non-spore forming types failed to grow and were apparently killed.

(35) Farbenfabriken vorm F. Bayer & Co. "Preparation of Arsenical Dye Insecticides and Fungicides." Dutch Roy. Pat. No. 415, 652. *Chem. Zentr. 2*, 1558 (1925).

Dyestuff salts of arsenic and arsenious acids are efficacious protective agents against fungi and bacteria and against insect pests. A solution of Malachite green arsenate kills parasitic molds even at great dilution and is an effective insecticide.

(36) Feibelmann. "Mildew Prevention." *Mell. Textilber. 6*, 586 (1925). Abs. *J. T. I. 17*, A12 (1926).

An adverse criticism of a paper by Straszewski (*Mell. Textilber. 6*, 497 (1925)) in which salicylic acid, formaldehyde, and para-formaldehyde were claimed to be the only reliable preventatives against mildew. The writer describes the excellent antiseptic properties of "Aktivin," a neutral odorless colorless substance which is soluble in water, stable, non-poisonous and does not deteriorate fibres. It also hydrolyses starch, thus abolishing the use of a second antiseptic in the finishing baths. Further he states that formaldehyde is useless in sizing baths, as it precipitates protein from sizing.

(37) Straszewski, P. "Prevention of Mildew." *Mell. Textilber. 6,* 497 (1925). Abs. *J. T. I. 17,* A11 (1926).

A critical review of all organic and inorganic antiseptics which shows that the only reliable preventatives against mildew on dressings and fabrics are salicylic acid and its derivatives, and also formaldehyde. The latter has recently been substituted by the less volatile para-formaldehyde.

(38) Allyn, L. B. "Bacterial Damage in Laundered Goods." *Starch-room Laundry J. 33,* 134–6 (1926). Abs. *Exper. Sta. Rec. 56,* 595 (1927); *J. T. I. 19,* A30 (1928).

Winter damage, usually met with between December and April, and more prevalent in the middle and east of the United States than in other sections of the country, is found only in cotton goods, and shirts appear to suffer most. Bacterial infection seems to be the principal source, and laundry men troubled with this type of damage are urged to leave the wet wash slightly acid rather than alkaline or neutral.

(39) Bright, T. B. "The Microscopical Examination of Damaged Cotton Hairs by the Congo Red Test and the Swelling Test of Fleming & Thaysen." *J. T. I. 17,* 396–404 (1926).

The relative merits of the Congo Red test and the swelling test are exhaustively discussed. Both appear to be useful in estimating damage to the fibres by heat, mechanical abuse, molds, or sulphuric acid. Good photomicrographs.

(40) Kendall, S. W. "Preparation of Insecticides and Fungicides." English Pat. No. 247,242. Abs. *J. T. I. 17,* A198 (1926).

Cellulosic or other vegetable, animal, metal or other materials are protected against insects, animals, or vegetable growths by treatment with compounds having as a base radical a rare earth metal or thorium, thallium, titanium, zirconium, or uranium, and as an acid radical a higher organic acid, the percentage of the compounds in the solution, emulsions or suspensions used being in the case of textile and like materials such as to preserve the absorbent properties of the materials unchanged. The materials may be impregnated or the compounds may be applied by double decomposition. The compounds may be used as ingredients or insecticides or fungicides, or of anti-fouling compositions or paints. Suitable compounds and their preparation among the examples described are: (1) Treatment of woolen fabrics for moth protection with a solution of lanthanum stearate in benzol or of thorium oleate in white spirit or successively with solutions of sodium stearate and cerium chloride. (2) Treatment of woolen rugs for protection against carpet beetles with a solution of titanium abietate. (3) Treatments of timbers.

(41) Morris, L. E. "Mildew in Cotton Goods." *J. T. I. 17,* T1–22 (1926). Abs. *Chem. Abs. 20,* 1327.

The paper deals with the relative liability of the more important sizing and finishing raw-materials to develop mildew damage. Flours, starches, dextrins and gums were for the purpose of investigation examined singly, while further the flours were only investigated in the unsteeped condition.

History of subject and source of materials are reviewed. The dis-

tinctions between Cassava flour, Cassava starch and tapioca are pointed out.

Experiments described dealing with seven types of fungi isolated from mildewed cotton goods. Rates of growth and time for spore production noted on each kind of sizing material:

1. Dextrins and wheat, rice and cassava flours permit most rapid growths.
2. Intermediate group—wheat and maize starches, gum tragacanth and soluble starch.
3. Slow growth on tapioca flour, sago, and farina. Very slight growth on farina treated with alkali.

Greater growth on flours than on starches attributed to higher sugar and nitrogen contents.

(42) THAYSEN, A. C. and H. J. BUNKER. "NOTES ON THE ACTION OF *B. subtilis* AND *B. mesentericus* ON CELLULOSE." *Biochem. J. 20*, 692–4 (1926). Abs. *J. T. I. 18*, A11 (1927).

Using a medium consisting of a solution of peptone and inorganic salts and filter paper and cotton fibres as sources of cellulose, the authors attempted to determine whether *B. subtilis* or *B. mesentericus* could visibly resolve the fibres, produce changes discernible by the swelling test, or cause a loss in weight. Using the strains formerly employed for the purpose by Trotman and Sutton, as well as other strains, it was found that no fibre destroying action could be proved even after long incubation periods.

(43) WINOGRADSKY, S. "ISOLATION AND PROPERTIES OF CELLULOSE DIGESTING BACTERIA." *Compt. Rend. 183*, 691–4 (1926). Abs. *J. T. I. 18*, A47 (1927).

Winogradsky's paper in confirmation of the work of Hutchinson and Clayton on *Spirochaeta cytophaga*. The characteristics of the organism and contents of this paper are well reviewed by Thaysen & Bunker, "Microbiology of Cellulose, Hemicelluloses, Pectins and Gums." (1927.) M. Winogradsky describes the resolution of the cellulose to a vaguely granular mucilage which seems to be an oxycellulose.

(44) WOOLF, D. G. "RARE EARTHS GIVE MILDEW-PROOF AND REPELLANCY." *Tex. Wld. 69*, 2869 (1926). Abs. *Chem. Abs. 20*, 2909.

It is stated that precipitation of the salts of several of the rare earth metals upon textile fabrics by the "Vivatex" or "Thoratex" processes imparts to the fabric a considerable degree of mildew repellency. Since these soaps are insoluble in bath water and gasoline, the protection is not greatly impaired by washing or dry cleaning.

(45) MORRIS, L. E. "MILDEW IN COTTON GOODS. ANTISEPTICS AND THE GROWTH OF MOLD FUNGI ON SIZING AND FINISHING MATERIALS." *J. T. I. 18*, T99–127 (1927).

Various substances were tested for their antiseptic power when used to prevent the growth of molds upon sizing and finishing materials. The characteristics necessary in a good antiseptic are listed as follows:

1. Must be fairly soluble in H_2O in order to mix well with the size.
2. Must be stable to heat, drying, oxidation, etc.
3. Must not alter the color of materials.

4. Should be odorless.
5. Must not tender yarn either because of acidic nature or of oxidizing powers.
6. Must not affect dyeing and finishing.
7. Must not affect parts of machinery.
8. Safe for handling.
9. Should not affect size so that "feel" of resulting fabric is altered.
10. Must be available in large amounts and at low price.

Results of Experimental Work

Substance	Toxic concentration in starch agar %	Phenol coefficient	Remarks
Zinc Chloride	0.8	0.16	Considerable specific differences
Zinc Hydroxide	About 1.0	0.13	v. s. sol.
Zinc Sulphate	1.0–2.0	—	—
Zinc Am. Fluoride	0.1	1.3	Tenders on drying
Zinc Si. Fluoride	0.13	—	—
Boric Acid	3.0	—	Considerable specific differences
Na Fluoride	0.8	0.16	—
Na Si. Fluoride	0.15 or less	0.87	Liable to attack Cu rollers
Thallium Carbonate	0.02	6.5	—
Cu Sulphate	0.10	—	Possible color
Cu Chloride	0.10	—	Possible color
Formaldehyde	0.05	2.6	Volatile irritating vapor
Hexamine	0.5	—	—
Phenol	0.13	1.0	Smell
O-Chlorophenol	0.08	1.6	Strong smell
O-Bromophenol	0.07	1.9	Strong smell
2 : 4 Dibromophenol	0.01	13.0	Faint smell, blisters
Tribromophenol	0.01	13.0	Smell
P-Nitrophenol	0.017	7.6	Yellow except in acid size
Dinitrophenol	0.02	6.5	Bright yellow
Zn Phenolsulphonate	About 3.0	—	—
Cresol	0.10	1.3	Smell
Dichloro-o-cresol	0.05	2.6	Smell
Tetrabromocresol	0.03 or less	4.3	Smell
Thymol	0.05	2.6	Expensive
Salcylic Acid	About 0.05	About 2.6	Should not be neutralized
Phenyl Salicylate (Salol)	0.08	—	—
Zn Salicylate	0.08	—	—
Napthalene	0.24	0.54	Smell
Tetrahydronapthalene	About 0.3	0.43	Smell
Napthalenesulphonic Acids and Na Salts	0.25	—	—
Thiocarbamide	0.80	0.16	—

In order to be of practical significance the antiseptics used in the work were tested upon culture media which consisted of sizing materials in agar jelly. The molds used were types which have been found on textile materials. Several cultures of *Penicillia* and *Aspergilli* (including *A. niger* and *A.-flavus*), *Rhizopus arrhizus, Cladosporium herbarium, Alternaria tenuis,* and a *Fusarium* were used as test organisms. A single colony was plated on each agar plate and growth measured by colony diameter and spore production.

Antiseptic efficiency was influenced by the following factors: (1) Acidity (pH) of the size mixture. (2) Specific relations between molds and antiseptics used. (3) The size mixture used (i.e., farina, flour, starch, etc.).

There is some evidence to show that antiseptic power and chemical structure are closely related and that the former may be predicted from the latter. No practical application of this theory has been used however.

(46) Sanborn, J. R. "The China Blue-aurin Cellulose Medium for the Physiological Effect of Cellulose Destroyers." *J. Bact. 14,* 395–7 (1927). Abs. *Chem. Abs. 22,* 1992 (1928).

Sanborn, who has previously made several studies of cellulose decomposing organisms recommends the use of a medium containing in addition to previously described nutrient materials, raw cotton cellulose precipitated from copper ammonium solution. China blue is used as an indicator; it shows a red color at pH 8.40 but is blue at higher acid concentrations.

A certain heat stable essential food factor was necessary for the growth of *C. folia.*

(47) Shapovalov, M. "The Two Most Common Decays of Cotton Bolls in the South-western States." *J. Agric. Res. 35,* 307–12 (1927).

Aspergillus niger (Van Tiegh) and *Rhizopus nigricans* (Eher) occur frequently as a cause of rotting in young cotton bolls. Most of this damage occurs in the Southwestern United States.

The fungi mentioned above were unable to attack the uninjured bolls, but did so vigorously as soon as the surface was broken either mechanically or by insect puncture.

(48) Thaysen, A. C. and H. J. Bunker. "The Microbiology of Cellulose, Hemicelluloses, Pectin, and Gums." Oxford Univ. Press (London) (1927).

General reference to microbiology of vegetable textile fibres and their associated substances.

(49) Waksman, S. A. "Principles of Soil Microbiology." London (1927).

General reference on microörganisms associated with the soil, and hence found as contaminants on textile fibres.

(50) Fargher, R. G., L. D. Galloway and M. E. Probert. "Salicylanilide Mildew Antiseptic." British Cotton Industry Research Assn. Eng. Pat. 323,579, Oct. 18, 1928. (*J. T. I. 21,* A198 (1930).

A process for protecting textiles, leather, rubber, timber, seeds, grain and other material against mildew and fungi, consists in treating them with

an arylamide of salicylic acid such as salicylanilide or its derivatives, for example, salicyl-ortho-anisidide, and salicyl-ortho (or para-) toluidide. Preferably the sodium salts of these compounds are used. In general, the anilide and ortho-alkoxyanilides and their alkali salts are more effective than other derivatives. Salicylarylanilides substituted in the salicylic nucleus, for example, 5-chloro-salicylanilide, β-rescorcylic anilide, etc., may be used. The materials or goods may be impregnated, coated, or treated with the solution by immersion, spraying or painting, or by adding the anilide to a sizing, dyeing, mordanting, or finishing bath. In the treatment of cotton or other yarns or fabrics a solution of the salicylanilide may be introduced into the sizing bath. The solution may be in water when the sodium salt is used or the arylamide may be dissolved in a solution of caustic soda. The compound may be applied in the form of a suspension in water. Preferably the amount used is such that the goods take up from 1/1000 part of their weight of the agent.

(51) Coolhaas, C. "Cleavage of Starch and Cellulose by Thermophilic Bacteria." *Cent. Bakt. Parasitenk* II Abt. *75*, 344–60, *76*, 38–44 (1928). Abs. *Chem. Abs. 23*, 1152–3 (1929); *J. T. I. 20*, A460 (1929).

Several carbohydrate splitting organisms were isolated from mud. As a medium for starch splitting organisms the following was used:

Agar	2%	$MgSO_4$	0.05%
NH_4Cl	0.1%		
K_2HPO_4	0.1%	Starch	

The most active species growing at 55–60° C. was *Bact. thermoamylolyticus.* Starch dissolved in 24 hours, 80% maltose in 9 days. Slight amounts of acids and no gas evolved. Products from starch, dextrose, or sucrose: CO_2, H, butyric acid, acetic propionic.

Bact. thermobutyricus produced much butyric acid.

Cellulose as filter paper was suspended in salt mixtures inoculated with mud. A thermophilic, aerobic, cellulose splitting organism isolated was identified as *Bact. thermocellulyticus.*

(52) Dubos, R. J. "The Decomposition of Cellulose by Aerobic Bacteria." *J. Bact. 15*, 223–34 (1924).

Dubos presents a method of counting aerobic cellulose decomposing bacteria by dilution and growth in a medium of the following composition:

$NaNO_3$	0.50 gm.	KCl	0.50 gm.
K_2HPO_3	1.00 "	$FeSO_4 \cdot 7H_2O$	0.01 "
$MgSO_4 \cdot 7H_2O$	0.50 "	H_2O (dist.)	1000 "

Carbohydrate—½ submerged strip of filter paper.

Fungi grow best below pH 5.0 but are retarded above pH 7.5 which is favorable to bacteria. Growth of the bacteria is favored by a low concentration of nitrogen salts and fermentation of cellulose usually occurs in less than 72 hours at 28° C.

Positive growth is obtained in the presence of very few cells and counting and isolation in pure culture are, therefore, easily accomplished.

(53) FARBENINDUSTRIE, I. G., A. G. "MOTH- AND MILDEW-PROOFING FABRICS." Eng. Pat. 312,163 (21/5/1928). Abs. *J. T. I. 20*, A557 (1929).

Salt of a quaternary phosphonium base used.

(54) SMITH, G. "THE IDENTIFICATION OF FUNGI CAUSING MILDEW IN COTTON GOODS; THE GENUS *Aspergillus*." *J. T. I. 19*, T93–100 (1928).

General morphology and characteristics of growth of *Aspergillus* species discussed. Isolations made from mildewed samples by agar shake dilutions using wort agar and prune-juice agar for isolation and Dox's agar for identification. Lactophenol used as a mounting medium in morphological tests

Lactic acid B.P.	2	parts	by	volume
Phenol (melted crystals)	2	"	"	"
Glycerol	1	"	"	"
Dist. H_2O	2	"	"	"

Sat. picric $\overline{A}$ in H_2O substituted for H_2O for purpose of photography.

The species described were divided into two groups: (I) Those found growing on fabrics under trade conditions. (II) Those found as chance contamination but not growing on fabrics.

Group I

1. *A. flavus* (Link)
2. *A. glaucus* group
3. *A. niger* (Von Tieghenn)
4. *A. repens* (Corda Saccardo)
5. *A. ruber* (Spieckermann and Brewer) Thom and Church
6. *A. sydowi* (Bainier and Chartory) Thom and Church
7. *A. terreus* (Thom)
8. *A. versicolor* (Vuillemin) Tirabaschi
9. *A. wentii* (Wehmer)

Group II

1. *A. candidus* (Link)
2. *A. chevalieri* (Mangin) Thom and Church
3. *A. effusus* (Tirabaschi)
4. *A. Flanipes* (Bainier and Sartory) Thom and Church
5. *A. nidulaus* (Eidam) Winter
6. *A. ochraceous* (Wilhelm)
7. *A. tamarii* (Kita)

Photomicrographs of each organism are given.

(55) WINOGRADSKY, S. "DECOMPOSITION OF CELLULOSE BY SOIL-MICRO-ORGANISMS." *Am. Inst. Pasteur 43*, 549–633 (1929). Abs. *Brit. Chem. Abs.* B615 (1929); *J. T. I. 21*, A320 (1930).

(56) I. G. FARBENINDUSTRIE A. G. "PROOFING TEXTILE FABRICS AGAINST MILDEW AND VERMIN." Eng. Pat. 349,004 (12/11/1929). Abs. *J. T. I. 22*, A545 (1931).

Preparations serving as preservatives, fungicides, disinfectants, and insecticides made up from a small proportion of bis-(hydroxy-aryl)-sulphide

or polysulphide or a salt or substitution product of the same plus a solid or liquid diluent and carrier.

(57) SEARLE, G. O. "THE ROTTING OF TEXTILES BY MICROÖRGANISMS. I. A LABORATORY TEST." *J. T. I. 20,* T162–74 (1929).

An excellent paper by Searle of the Linen Industry Research Association. Laboratory tests upon the strength of many samples of linen and cotton ducks were conducted.

A technique using Berkefeld filter candles and large test tubes is developed for inoculating the samples with the micro-flora of soil in a manner designed to simulate those found when the fabrics are in normal use. The conclusions of the author are as follows:

1. There is no significant difference in susceptibility to microbiological attack between the cotton and linen ducks.

2. In both the weft is slightly less resistant than the warp.

3. The progress of the deterioration follows the same course in both warp and weft, namely, little effect during the first week, a sharp rise to the fourth week, a slowing down to the end point. It is highly probable that the last phase is due to the collection of staling products and this will be tested in another series of strips irrigated weekly.

4. The most commonly occurring fungus was *Stachybotrys sp.*

The growth of microörganisms upon the fibre, resulting in loss of strength, did not affect the viscosity of the fibre in cuprammonium solution.

(58) SMITH, G. "THE MILDEW PROBLEM IN THE COTTON INDUSRTY." *Tex. Mfr. 55,* 421–23 (1929); *Tex. Merc. 81,* 452, 472 (1929); *J. T. I. 20,* 176–78 (1929).

A general discussion of the causes of mildew and it's prevention. Attention is called to the fact that the common antiseptics Zn Cl_2 and salicylic acid are not always effective or suitable preventative agents.

(59) TOMKINS, R. G. "EFFECT OF HUMIDITY ON GROWTH OF MOULDS." *Prac. Roy. Soc. B105,* 375–401 (1929). Abs. *J. T. I. 21,* A158 (1930).

Using relative humidities of 90–100% the author studied the germination of various fungi in the presence and in the absence of nutrients. He discovered that the range of humidities at which germination is possible is greatest at their optimum temperature and narrows considerably as the temperature is changed to one side or the other. Nutrient materials make possible an increase in the ranges of temperature and humidity over which germination and growth are possible.

(60) WHITE, C. B. "MILDEW PROOFING TEXTILE MATERIALS." U. S. Pat. 1,717,483 (18/6/1929). Abs. *Chem. Abs. 23,* 4085 (1929); *J. T. I. 20,* A665 (1929).

Rare earth metal compound, insoluble in alkali.

(62) ANON. "APPLICATION OF 'RASCHITE' ANTISEPTIC." *Die ges. Band-Spitzen-u. Breitweb-Ind. 9,* 10 (1930); *Textilber. 11,* 796 (1930). Abs. *J. T. I. 22,* A153 (1931).

"Raschite" is a p-chlor-m-cresol product recommended as cotton antiseptic in 1% solution. Soluble to the extent of 6% in H_2O. 0.1% solution is 3x as antiseptic as $HgCl_2$.

(63) ANON. "DETECTION OF MILDEW." *Tex. Wkly. 6,* 71 (1930). Abs. *J. T. I. 21,* A613 (1930).

Two solutions used:

1. Lactophenol-phenol 10 gm., Lactic acid 10 cc., glycerine 20 cc., dist. H_2O 10 cc.
2. Cotton blue 1 gm. in 100 cc. H_2O.

Spot fabric with lactophenol; warm for two minutes; immerse for short time in warm cotton blue solution; wash with H_2O; spot with lactophenol, warm, wash with same; observe under microscope.

(63) CONN, W. T. "NET PRESERVATION TREATMENTS." U. S. Dept. Commerce, Bur. Fisheries Document No. 1075, Appendix to Report of Commissioner of Fisheries for the Fiscal Year 1930, 5 pp. (1930).

The total value of fish nets in use every year in the United States is about $16,000,000. About 1/3 of these are replaced annually. A large part of this replacement is due to deterioration of the nets by bacterial or other microbic intervention. The abrasion of nets and the accumulation of slime upon them hasten their destruction.

Treatment with compounds such as copper oxide, copper oleate, and mercuric oxide or mixtures of these are recommended to keep nets free from biological growths. Tans and resins are used to resist abrasion and benzol or kerosene as solvents for applying the mixtures.

(64) FARGHER, R. G., L. D. GALLOWAY and M. E. ROBART. "THE INHIBITORY ACTION OF CERTAIN SUBSTANCES ON THE GROWTH OF MOLD FUNGI." *J. T. I. 21,* T245–60 (1930).

Properties of good antiseptics for use in cotton industry: (1) Must not volatilize during boiling of size or finishing paste, or drying of yarn or filled cloth. (2) Must be soluble enough to assure even distribution throughout size mixture. (3) Must be unaffected by heat, metallic surfaces, or substances in size or finishing paste. (4) Must not have odor or color, nor one which will develop in acid or alkali. (5) Must have no action on cotton. (6) Must not affect dyeing or finishing. (7) Should not cost more than zinc chloride.

The authors present the results of experiments testing the fungicidal effects of 161 compounds upon a representative group of resistant mold fungi commonly found upon cotton. *Aspergilli, Penicillia, Cladosporium, Fusarium* and *Rhizopus* and one species of *Alternaria* were used in the tests. The medium used was a 6% paste of soft wheat flour or a 2% suspension of flour in 2% agar jelly. Incubation at 25° C. tests were carried out in triplicate and a single inoculation was made in the center of each plate. Growth was measured by increase in colony diameter.

Inorganic salts, organo-mercury compounds and numerous organic compounds were tested. The salts of aluminum, barium, boron, cadmium, copper, cerium, lanthanium, lead, mercury, rubidium, sodium fluorides, thallium, uranium, zinc, and thorium were tested. The organo-mercury compounds were mercury derivatives of phenol and toluene, and related aromatic compounds. The organic compounds are largely aromatic and their substitution products; some nitro and sulphonic acids are included. Procedure for preparing many of the above are outlined.

The work of previous investigators is confirmed in that every fungicide is not equally effective against all molds. A table of results is given

The substances of outstanding toxicity are: (1) Salicylanilide. (2) O-Chloromercuriphenol. (3) P-acetoxymercuriacetanilide. (4) Thallium carbonate. (5) P-nitrophenol. (6) Trichlorophenol.

(65) GALLOWAY, L. D. "THE FUNGI CAUSING MILDEW IN COTTON GOODS." *J. T. I. 21*, T277–86 (1930).

Mildew occurs most commonly in gray cloth. Most of the infection seems to come from the raw cotton and some, such as *A. niger*, may even remain from an infection of the cotton boll itself. Other sources of infection are the air and the machinery in course of manufacture. Treatment with lactophenol and cotton blue renders the infecting spore and mycelium readily visible.

It is stated that samples of cloth with a moisture regain as high as 9.0% showed no mildew but cloths with a regain of 9.5% to 10.0% mildewed quite readily. High percentages of CO_2 are said to inhibit mold growth.

The source of infection cannot be determined or even approximated by identifying the organisms involved because of the diverse conditions under which they grow. *Penicillia* tend to grow at lower temperatures than the *Aspergilli*. Humidity is an important factor. *A. glaucus* develops at low humidities whereas *Mucors* (including *Rhizopus*) develop only at high humidities not generally encountered in this work.

The results of fungus growth are as follows: Smell, musty; stains—perithecea, colored products, spores; acid production, oxalic(?) citric(?); alkali production, protein degradation products(?); tendency, cellulose digestion.

A list of about 180 molds are listed together with their sources, cloth staining ability, acid production, and cellulose digestion power. Cultures of these are maintained at the Shirley Institute.

Identification

Lactophenol is recommended as a mounting medium.

Aspergillus .....Thom and Church
Smith
Penicillium .....Thom
Westling
Mason
Biourge
Fungi Imperfecti.....Lindau
Waksman .....Translation of Lindau on soil fungi.

(66) IMPERIAL CHEMICAL INDUSTRIES LTD. AND DUPONT DE NEMOURS. "PROOFING MINE VENTILATION TUBING." Eng. Pat. 350,833 (5/9/-1930). Abs. *J. T. I. 22*, A546 (1931).

Hoses and heavy duck made resistant to fungi, water, and fire by soaking in 2½% solution of zinc salicylate and filling with a mixture of crude rubber, litharge, sulphur, barytes, Zn. salicylate, pine tar, and paraffin.

(67) JENNISON, M. W. "DETECTION OF FUNGUS *Mycelium* IN MILDEWED COTTON FABRICS." Science *72*, 346–7 (1930).

Use of Pianese IIIb as a differential stain is favorably regarded. Recommends washing in 95% alcohol, staining 15–45 minutes, washing with H_2O, decolorizing with acid alcohol and mounting for examination.

(68) KOUTIEICHTCHIKOF, V. A. "EFFECT OF SPINNING, SIZING, AND SCOURING ON *Aspergillus* INFECTED COTTON." *Izv. Tekstiln. Promychl. 9*, 57–60 (1930); *Chim. et. Ind. 24*, 945–6 (1930). Abs. *J. T. I. 22*, A208 (1931).

The author studied the effect of technical processes upon *Aspergillus* fungi growing on cotton. The results show that mechanical processes such as spinning and weaving are not capable of freeing the material from the fungus and that apart from unfavorable conditions, e.g. high temperatures, it continues to develop on the cotton. Sizing does not destroy the fungus; the heating is not sufficiently long nor high and food material is added. The low concentration of acid and alkali usually used in textile processes are too low to kill the fungus but boiling out with concentrate alkali for 6 hours under pressure destroys it completely.

(69) LLOYD, L. L. "THE USE OF ANTISEPTIC AGENTS FOR THE PREVENTION OF MILDEW." *Am. Dye. Rptr. 4*, 608–9 (1930).

Goods most likely to mildew are those filled with starches, glue, casein, soaps, soluble oils and glycerine. Jeans or dungarees mildew readily because they are filled with glue or casein in an alkaline condition. Soaps and soluble oils such as oleines are said to aid mildew.

Ortho cresol, phenyl salicylate (Salol), napthyl salicylate and the anilide or napthalide of salicylic acid recommended for use as antiseptic.

Ample ventilation of stored goods and shipment of goods in a dry condition instead of conditioned to an atmosphere of 70% relative humidity are recommended as measures for mildew prevention.

(70) ROBERTS, HERBERT C. "MILDEW IN TEXTILE MILLS." *Am. Dye. Rptr. 19*, 431–3 (1930).

Good discussion of mildew problem from an economic rather than a chemical or biological viewpoint.

Properties of ideal antiseptic: (1) Must not injure material. (2) Must not interfere with subsequent processes. (3) Must not evaporate or be driven off under ordinary conditions. (4) Must be stable, and must not break down or react with other materials. (5) Must not start any electrolytic action which might corrode metal parts. (6) Free from odors. (7) Must not be injurious to worker. (8) Must be effective in small amounts. (9) Must not discolor goods. (10) Should not greatly increase cost of processing.

Benzoates and complex fluoride salts are recommended as being the best, because of their solubility, lack of odor, and effectiveness in small concentration.

(71) ROBERTSON, A. C. and W. H. WRIGHT. "INVESTIGATIONS UPON THE DETERIORATION OF NETS IN LAKE ERIE." U. S. Dept. of Commerce, Bur. of Fisheries Document No. 1083 (1930).

Lake Erie was chosen as a location for study of fish net deterioration because of its warm shallow water and other features which make it an important inland fishery.

Rotting of nets was definitely shown to be due to bacterial action and not to green algae or a red species of hydra.

Samples of cotton twine rotted in the lake water showed a development

of slime and a great loss in tensile strength. Great numbers of bacteria were found on rotted fibres. These were plated by streaking on Dubos's medium:

$NaNO_3$	0.50 gm.	KCl	0.50 gm.
K_2HPO_4	1.00 "	$FeSO_4 \cdot 7H_2O$	0.01 "
$MgSO_4 \cdot 7H_2O$	0.50 "	H_2O	1000 "

pH = 7.3

Ammonium sulphate later substituted for $NaNO_3$.

Cellulose was prepared, *not by precipitation from copper solution,* but by dissolving 75 grams of pure absorbent cotton in 16 cc. of 72% H_2SO_4, precipitating by dilution and washing. 1% of dried, precipitated cellulose and 1.5% agar added to Dubos medium.

Many colonies obtained but some showed a clear zone of cellulose digestion which others did not. Mixed cultures suspected. Usually rods and non-spore formers. Isolation difficult, best results by streaking on agar plate. Impure liquid cultures most active on cellulose. The power of the organisms to destroy cellulose is best retained when they are grown on raw cotton fibres. The organisms thrive at low temperatures and an aerobic or slightly less than aerobic O_2 tension.

All nets are subject to heavy contamination from the lake waters and the contaminants are particularly abundant in the slime occurring upon nets in use. Nets which have been dried may contain bacteria capable of resuming growth upon the renewal of moisture supplies. Long drying apparently kills these organisms.

Tests of various net preservatives indicate that mixtures of copper oleate and copper resinate are most satisfactory from the standpoints of preservation of the structure, feel, and functions of the nets.

(72) Galloway, L. D. "'Diamond Spot' Mildewed Cotton Fabric: Investigation." *J. T. I. 22,* T494–96 (1931).

An investigation of "diamond spot" mildew using *Cladosporium, Aspergillus niger, Helminthosporium, A. terreus,* and *Fusarium* as test organisms revealed the fact that the phenomenon was due to growth of moulds along the warp and weft of cloth from a central point of inoculation and that any of the test organisms was capable of producing the diamond shaped growth. A very high percentage of moisture 30–60% aids in forming the diamond shaped colonies.

(73) Itano, Arao, and Satiyo Arakawa. "New Species of Cellulose Decomposing Bacteria, *Cellvibrio Calida n. sp.*" *Proc. Imp. Acad. (Tokyo) 7,* 367–8 (1931); *Chem. Abs. 25,* (1931).

A new organism isolated from dry-farm soil is identified, described and named *Cellvibrio calida n. sp.* It reduces nitrate to nitrite in cellulose synthetic liquid culture; it produces nitrite but no NH_3 in Dunham solution; no indole in Dunham solution or nutrient broth; catalase is detected in cellulose synthetic liquid culture; it ferments xylose, glucose, fructose, maltose galactose, lactose, sucrose and starch but not mannitol. Optimum pH for cellulose decomposition in cellulose synthetic liquid culture is 7.8–8.1; action is hindered at pH 6.8 and stopped at pH 6.2. Oxycellulose and a reducing sugar are intermediates.

(74) ROBERTSON, A. C. "PRESERVATION OF TEXTILE FISH NETS." *Ind. and Eng. Chem. 23,* 1093–8 (1931). Abs. *J. Soc. Dyers & Col. 48,* 107 (1932).

A 25% solution of Cu resinate in water-gas tar oil is used for treating flexible gill nets. Trap and pound nets which of course need not be flexible are often treated with a paint-like dip containing 5½% finely divided CuO in suspension. Nets of the latter type need a certain amount of armoring to resist friction and to divert fish into the pockets. Simpler and cheaper treatments are available if desired.

(75) SIMOLA, P. E. "DECOMPOSITION OF CELLULOSE BY MICROÖRGANISMS. II. THE CHEMISTRY OF THE BREAKDOWN OF CELLULOSE BY THE AEROBIC SPORE-FORMING CELLULOSE BACTERIA." *Ann. Acad. Sci. Fennicae, Ser. A 34,* No. 6, 1–115 (1931).

Cultures of *Cellulobacillus myxogenes* and *Cellulobacillus mucosus,* the organisms previously isolated, were grown in paper pulp in presence of toluene to suppress oxidative metabolism, and the presence of cellulase and cellobiase established by the isolation of cellobiose and glucose, resp. The cellulase action is increased by phosphate in optimal concn. of 0.03 M, and has its optimum pH at 6 to 7 and temperature at 37°. By pressure and filtration, a cell-free enzyme solution was prepared, whose optimal conditions, both for cellulase and cellobiase, were at pH 6° to 7° and 37°. The CO_2 production from the organisms growing either on glucose or cellulose was only equivalent to ½–⅔ of the carbohydrate destroyed, and the respiratory quotient was below 1, though varying somewhat with the source of N. About 30 mg. inorganic N was converted to the organic form, per gram of glucose or cellulose metabolized. A part of this N is excreted by the organisms as a slimy heat-coagulable protein, containing 16.2% N. No free amino N was excreted, except after periods long enough to allow autolysis of the bacteria. Of the remaining C of the carbohydrate 5–10% appeared as HCO_2H and HOAc in the mol. ratio of about 1:3, 1% as EtOH, traces as $MeCHOHCO_2H$ and MeCHO and part as ether-insol., non-volatile colored acids, reducing Fehling solution and giving a naphthoresorcinol reaction. These acids, apparently keto-hydroxy acids are considered to be similar to, if not identical with, the non-colloidal humic acids.

(76) I. G. FARBENINDUSTRIE A. G. "INSECTICIDES, FUNGICIDES, DISINFECTANTS AND PRESERVATIVES." Eng. Pat. 360,405. Abs. *J. Soc. Dyers and Col. 48,* 50 (1932).

Compounds of the general formula $(HO\text{-}AR)_2$ X when Ar is an aryl residue and X is oxygen, or nitrogen attached to hydrogen or an alkyl group are used.

Example: Wool treated with 3% bis-(2-hydroxy-3:5-dibromophenyl)-oxide from cold aqueous solution is moth and mildew proof.

(77) I. G. FARBENINDUSTRIE A. G. "INSECTIDICES, FUNGICIDES, DISINFECTANTS AND PRESERVATIVES." Abs. *J. Soc. Dyers and Col. 48,* 50 (1932).

A polyhalogenated aromatic hydroxy-compound, its alkali salt, nuclear substitution product or ether, is treated with an aliphatic amine or its substitution product except amines containing acid groups.

Example: 40 pints by weight trichlorophenol are dissolved in 60 pints by weight of a mixture of mono, di; and trihydroxyethylamines; 0.1–0.2% of this solution preserves sizing materials etc.

(78) HARVEY, R. and H. V. DAY. "MILDEW-PROOFING FABRICS." United States Pat. 1,827,083 (1932). *Chem. Abs.* (1932).

A fabric such as duck is treated with a pyroxylin dope containing Zn resinate. Use of other insoluble metallic soaps is also mentioned.

(79) HERSTEIN, KARL M. "PREVENTING MILDEW IN SIZING AND FINISHING." *Tex. W. 82*, 78–9 (1932). Abs. *Chem. Abs. 26*, 4478 (1932).

Ten guiding principles for selecting a mildew proofing agent for addition to the size and five factors for consideration in placing the blame for mildew damage are enumerated.

(80) IMPERIAL CHEMICAL INDUSTRIES LTD. "PROTECTING TEXTILES." Eng. Pat. 323,597 (1932). *Chem. Abs.* Fr. 715,032 April 9, 1931.

Preparations of aromatic amides of salicylic acids for use as protecting agents for textiles as described in Brit. 323,579 (*C. A. 24*, 3119), are made by pulverizing or grinding the amide with water in the presence of a wetting agent such as sulfite cellulose liquor, until the particles have linear dimensions below 2μ.

(81) MARCARD, R. "ACTION OF DYES ON MILDEW FUNGI." *Chimie et Ind. 27*, 15–17 (1932). Abs. *J. T. I. 23*, A229 (1932).

In connection with control of mildew on vines, laboratory tests have been made with *Rhizopus nigricans* and *Penicillium glaucum*. Additions of Brilliant Acridine Orange E or Brilliant Phosphine S to the nutrient media in proportions of 1/5000 retarded the development of the fungi. The effect increased with increasing proportions of the dye and solutions containing 1 part/2000 remained sterile when exposed to the air. The effect of the dye appears to be greater in the light than in the dark and it is suggested that the action may be due to photo-sensitization.

(82) SATOH, S. "CELLULOSE DECOMPOSING FUNGI." *Japanese J. Bot. 6*, 49 (1932). Abs. *J. T. I. 24*, A71 (1933).

The action of the following fungi in dissolving cellulose is demonstrated: *Piricularia oryzae, Ophiobolus miyabeanus, Helminthosporium sp., Fusarium, Gibberella saubinettii,* and *Rhizoctonia papayae.*

To Improve Raw Cotton Quality

RECOGNIZING that obtaining a higher quality of raw material is an important way of aiding the cotton producer and the textile industry, the Textile Foundation recently has ear-marked some of its funds for aiding research on methods of improving the quality of raw cotton. Convincing evidence of this need can be found in the literature of the subjects of seed breeding and selection, and of single-variety communities, compiled largely by experts connected with the Federal and State departments of agriculture. Similar evidence may be found in reports of the international cotton conferences held in Atlanta, Ga., in 1907 and in New Orleans in 1920. Leading spinners and cotton men have long been in general agreement as to this need, but heretofore it has been taken for granted that educational and research work designed to attain these ends were proper functions of the Federal government and of the cotton states.

The Textile Foundation explains that the "decision to go forward with this project was reached after Secretary of Agriculture Wallace and Stuart W. Cramer of Cramerton, N. C., as a sub-committee of the Board of Directors, developed convincing evidence of the value of such practical research. In the course of the preliminary inquiries, Messrs. Wallace and Cramer were fortunate in securing the advice of men of professional and practical experience.

"Part of the fund is being used during the current year to help finance comprehensive regional varietal trials of a number of the more or less standard varieties of cotton by the Bureau of Plant Industry of the U. S. Department of Agriculture and the State experiment stations in North Carolina, Tennessee, Arkansas, Oklahoma and Texas.

"It is generally recognized by the cotton trade, both in the United States and abroad, that the spinning utility of the great bulk of the cotton now grown in this country is far below what it should be. One of the principal causes of this poor quality is that too many different varieties are grown in the same locality. The result is that the cotton becomes mongrelized through cross pollination between different varieties and by the mixing of seed from different fields at the gins.

"More than 1200 different names for cotton varieties being grown in the United States have been recorded and about 400 of these have been added in the last 10 years. Only about 5% of the approximately 600,000 tons of seed required to plant the crop comes from seed breeders, the remaining 95% being largely of such mongrelized gin-run stocks. Seed mixing and primitive cultural practices have resulted in millions of dollars needlessly lost every year to the textile industry and to growers, through low yields of short, irregular fibre of poor spinning quality.

"The length of staple and quality of the crop can be improved rapidly through a larger use of pure seed of superior existing varieties. Premium varieties do not deteriorate or run out if the seed is kept pure. The establishment of communities within which only one variety is grown and

(*Continued on page 489.*)

Abstracts

This section is compiled under the direction of the Committee on Abstracts and Bibliography: Prof. E. R. Schwarz, Chairman, Dr. W. E. Emley, Prof. Louis A. Olney and M. W. Weiss.

I. Fibres (Synthetic and Natural) and Fibre Analysis

Action of Alkaline Copper Solution on Silk Fibroin. VII–VIII. Solution Phenomena in the System Fibroin-Copper-Amine-Alkali. Y. Takamatsu. *J. Soc. Chem. Ind., Japan* 37, Suppl. binding, 1934, P. 107–10; *Chem. Abs.*, 1934, V. 28, P. 1539, 3239. (W)

Natural Silk: Solution of. Y. Takamatsu. *Artificial Silk Staple Fibre J. Japan*, 1934, V. 2, P. 42–5, 82–5, 122–5; *Chem. Abs.*, 1934, V. 28, P. 3908. (W)

Oiling of Carded Wool. R. Vinces. *Rev. chim. ind.*, 193?, V. 41, P. 307–11.

Practical directions are given on the use of olein, together with a brief discussion of new products recently proposed. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3908.) (W)

Sericin Fractions of Silk. H. Mosher. *Am. Silk Rayon J.*, April, 1934, P. 43–4.

The sericin of silk is subdivided into three fractions designated as sericins A, B and C. By means of fermentation and other studies, each of these is shown to be a sep. entity. Sericins A and B are closely allied chemically, and the latter is readily transformed into the former by hydrolysis. Sericin C, the innermost layer of the gum fraction, is insol. in all common solvents, is almost completely resistant against enzymic activity and possesses but slight ability to emulsify oils and fats. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3909.) (W)

Sorption of Iodine Vapor by Fibres. I. Plant Fibres. Ernst Beutel and Artur Kutzelnigg. *Monatsh.*, 1934, V. 64, P. 41–52; *Chem. Abs.*, 1934, V. 28, P. 3590. (W)

Sulfated Fatty Alcohols. Cornelia A. Tyler. *Soap*, 1934, V. 10, P. 21–3, 65.

Na lauryl sulfate and Na oleyl sulfate have been used in the textile industry for some time and have been tried in wool scouring with one lb.

to 960 lb. wool and one lb. to 1200 lb. wool, resp. The Na oleyl sulfate is more efficient as a general wool-scouring agent than the lauryl product. The criterion of efficiency is the amt. of grease left in the wool. Advantages claimed for the alc. sulfates as scouring agents are that the wool has a fine soft feel, is clear, bright and very open and free from sticky ppts. As an auxiliary agent in dyeing, the lauryl and oleyl sulfates give cleansing and leveling effects superior to those of soap and may be used under acid, neutral or alk. conditions. They are also particularly adapted to the soaking of silk for throwing, as they have less tendency to remove sericin than do strongly alk. soap emulsions. In the processing of rayon skeins all operations must be held to a min. to insure the best winding qualities. The rinsing can be greatly reduced if the scouring is done with the alc. sulfates. Na stearyl sulfate is suitable only as a finishing agent. The limiting factor in the sale of the alc. sulfates is their high cost; it is four or five times that of soap. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3608.) (W)

Wild Silks on European Market: Appearance of Some Less-known. G. Colombo. *Boll. uff. R. Staz. sperim. Seta*, 1932, V. 2, P. 2–5 (through *Chem. Zentr.*, 1933, V. I, P. 2193).

Caligula japonica, the most important of the wild silk referred to, is being embodied in fancy fabrics. (Copied complete from *J. T. I.*, May 1933, P. A238.) (S)

Wool Fibres: Spirality in the Growth of. *Sci.*, May 25, 1934, P. 477–479.

Very brief reference to some of the work done in the endeavor to explain the formation of crimp in wool. No conclusions are noted. (S)

Wooled Sheep: Evolution in. J. E. Duerden. *Wool Rec.*, 1933, V. 43, P. 463–465 and 469.

The birthcoat of the lamb is described, this being essentially alike in all wooled sheep, the differences distinguishing the breeds appearing later. (Copied complete from *J. T. I.*, April 1933, P. A177.) (S)

II. Yarns and Fabrics

Linen: Process Giving Cotton the Appearance of. Th. Baumann. *Bull. soc. ind. Mulhouse*, 1933, V. 100, P. 112. (Sealed note of 1920.) Report. René Speitel. *Ibid.*, P. 112–13.

The bath contains 64 g. H_2SO_4 (66° Bé.) and 36 g. formol (40% CH_2O). The goods are treated for 10–15 sec. at 15°, washed, treated with dil. Na_2CO_3, washed and dried. S. reports that the process had not been described in 1920 but has been used since. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3893.) (W)

Mercerizing: Effect of—on the Tensile Strength and Expansion of Cotton Yarns (Hosiery) by Different Degrees of Stretching. K. Langer. *Mell. Textilber.*, 1934, V. 15, P. 165–9.

The expts. demonstrated that the strength of hosiery yarns is not affected by normal stretching in the process of mercerizing, provided the

material in its spinning and other properties is suitable. While the strength of cotton and hosiery yarn is actually improved by treating with NaOH, the differences in the increased strength between hosiery yarns mercerized with Mercerol (Chem. Fabrik vorm. Sandoz, Basle, Switzerland) and those cooked and mercerized with pressure are negligibly small. The av. increase in strength is 35%. The expansion of material is decreased with the increasing stretching, and is for the hosiery yarn mercerized with Mercerol generally higher. The cause of impairment of strength of hosiery yarn after mercerizing must be sought in the inferior properties of the crude yarn. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3909.) (W)

RAYON: LUSTER OF. I. THE LUSTER OF RAYON THREAD. H. Sobue. *Cellulose Ind.* (Tokyo), 1934, V. 10, P. 5–11; *Abstracts* (in English) p. 1–5.

The variation in the luster of a given rayon thread is explained by geometrical optics, *i.e.*, by the direction of the plane of reflection of the light in relation to the direction of the filaments of rayon (which are assumed to be cylindrical and parallel). Exptl. proof is given. The effects of twist, increase in the no. of filaments, surface irregularities, residual S. of viscose rayon, etc., on the luster are also considered. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3909.) (W)

SILK FABRICS: CHANGES OF—IN WEATHERING TEST. S. Saito. *J. Soc. Rubber Ind. Japan*, 1934, V. 7, P. 92–102.

Exposure of silk fabrics to direct sunlight for 49 days gave a loss of 95.3% of its tensile strength; coating of antioxidants had little effect. Cotton fabrics, on the other hand, gave a very strong resistance to weathering. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3591.) (W)

WOOLENS: MILLING OF HEAVY. Richard Kilburn and Sons. *Tex. Mfr.*, 1934, V. 60, P. 26.

The milling time is shortened by a new form of spout which can be applied to milling machines for meltons, etc. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3908.) (W)

WORSTED WARP AND WOOLEN WEFT POPLINS AND REPS: FINISHING OF. G. L. Atkinson. *Tex. Mfr.*, 1933, V. 59, P. 407–8.

Instructions are given concerning faults, crabbing, steaming, scouring, dyeing, drying, cutting, perching, finishing, tentering and pressing. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3908.) (W)

WOVEN FABRICS: USE OF COLOR IN. R. H. Wright. *Tex. Mfr.*, 1933, V. 59, P. 471–2. Further Effects of Color. *Ibid.*, 1934, V. 60, P. 10, 33. Color, Warping and Weave. *Ibid.*, P. 48.

A short discussion of color theory with samples of woven fabrics illustrating the effects of the weave on the color of materials woven from dyed yarns, and color harmony. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3907.) (W)

III. Chemical and Other Processing (Not Otherwise Classified)

Adsorption of Dyestuffs by Cellulose. II. Influence of Temperature. W. M. Garvie, L. H. Griffiths and S. M. Neale. *Trans. Faraday Soc.*, 1934, V. 30, P. 271–8; *Chem. Abs.*, V. 27, P. 5544.

Measurements were made of the absorption of two direct dyestuffs (Chlorazol Fast Red K and Heliotrope 2B) by viscose sheet and by cotton cloth over a range of temps. from 25° to 100°. The rate of diffusion of dye into viscose sheet is very roughly doubled for 20° temp. rise. The amt. of dye absorbed at equil. is very roughly halved for 30° temp. rise. At any given temp. the addn. of NaCl causes the rate of diffusion into viscose sheet to rise to a max. and then fall, whereas the absorption at equil. steadily increases. Viscose sheet normally takes up more dyestuff than cotton, but the difference decreases and is ultimately reversed when the absorption is reduced, either by raising the temp. or by reducing the amt. of added electrolyte. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 2539.) (W)

Adsorption of Iron Compounds on Fibres of Cellulose Origin and Its Prevention. Kōtarō Tanemura and Minazō Yoshida. *J. Soc. Chem. Ind., Japan* 37, Suppl. binding 1934, P. 43–4.

Cellulose acetate silk did not absorb sufficient Fe from solns. of any pH to be detectable by the tannic acid test. This test gave neg. results on six kinds of com. viscose rayon from different makers, but the degree of adsorption of Fe after steeping in a $FeSO_4$ soln. was different from all six samples, showing no relation to the Cu nos. but being proportional to the Ca contents. A summary of the causes of Fe fixation of cellulose fibres is presented and methods are given for preventing Fe adsorption. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 2189.) (W)

Aluminum with Regard to Textile Dyeing and Finishing Machinery. G. L. Atkinson. *Tex. Col.*, 1934, V. 56, P. 129–30.

The advantages of more frequent use of Al for textile finishing machinery in place of iron and steel are pointed out. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 2909.) (W)

Azo Dyes: Proposal for the Nomenclature of. Hermann Eichler. *Chem.-Ztg.*, 1933, V. 57, P. 1011; *Chem. Abs.*, 1934, V. 28, P. 2188. (W)

Azo Dyes and Intermediates. XII. Preparation of "Homologous" Azo Dyes of Higher Molecular Weight. Paul Ruggli and Oskar Braun. *Helv. Chim. Acta*, 1933, V. 16, P. 858–73; *Chem. Abs.*, V. 27, P. 1178; *Chem. Abs.*, 1934, V. 28, P. 2188. (W)

Bleaching of Wool: Stabilization of Hydrogen Peroxide in the. II. Effect of Phosphate, Ketone and Alcohol Sulfonate. R. Folgner and G. Schneider. *Mell. Textilber*, 1934, V. 15, P. 24–7.

The catalytic effect of NH_3 on the decompn. of H_2O_2 was greatly decreased by adding lauryl alc. sulfonate and acetone. The strength and

elasticity of wool yarn bleached in these baths were generally increased. The best results were obtained with lauryl alc. sulfonate and acetone in alk. solns. also contg. $Na_4P_2O_7$. Igepon T also gave good results. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3239.) (W)

CELLULOSE GEL: STRUCTURE OF. IV. CELLULOSE STRUCTURE AND DIRECT DYEING. K. Atsuki and H. Sobue. *Cellulose Ind.* (Tokyo), 1934, V. 10, P. 31–7, *Abstracts* (in English) P. 7–12; cf. *Chem. Abs.*, 1934, V. 28, P. 395, 3237. (W)

CHROMIUM SALTS: ABSORPTION OF—BY NATURAL SILK. L. P. Michel. *Tiba*, 1934, V. 12, P. 89–93; *Russa*, 1934, V. 9, P. 185–9.

Tests carried out under quite different conditions on the whole bore out the findings of Hishiyama and Sekiguchi (*Chem. Abs.*, V. 26, P. 3380, 5761). The amt. of CrO_3 fixed by silk increases with the concn. of the bath (up to about 1%), the temp. (up to boiling), the time (up to 30 min.) and the alky. of the bath. Addn. of neutral salts had but little effect on the fixation of CrO_3, while addn. of mineral acids decreased it. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3239.) (W)

COLD DYEING OF CELLULOSE ACETATE WITH RESERVE PRINTINGS. P. Barsy. *Russa*, 1934, V. 9, P. 105, 107.

Practical operating directions. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3237.) (W)

DELUSTERING OF ACETATE RAYON GOODS. USE OF PHENOL AND OF PINE OILS. Jean Rolland. *Russa*, 1933, V. 8, P. 933.

A brief discussion of the precautions required to obtain good results. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 2540.) (W)

DELUSTERING OF RAYON. J. C. Meiss. *Chem. Weekblad*, 1934, V. 31, P. 214–22; *Chem. Abs.*, 1934, V. 28, P. 3238. (W)

DIRECT DYEINGS MECHANISM OF. J. S. Brown. *Tex. Col.*, 1934, V. 56, P. 83–5, 132; *Chem. Abs.*, 1934, V. 28, P. 2909. (W)

DYEING: SANITATION AND VOCATIONAL DISEASES. A. Thomas. *Russa*, 1933, V. 8, P. 943–9.

A brief outline of vocational hazards in the dyestuffs and dyeing industry and of sanitation measures by which they can be prevented or overcome. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 2539.) (W)

DYEING INDUSTRY: USE OF STAINLESS STEELS IN THE. Andre Michel. *Rev. gen. mat. color.*, 1934, V. 38, P. 67; cf. *Chem. Abs.*, 1934, V. 28, P. 647.

Most stainless steels which are resistant to HCl do not resist $SnCl_4$. A Cr-Ni-Mo steel is not attacked by $SnCl_4$ of 30° Bé. at 20° and 50° for 122 hrs. Polished surfaces of stainless steels, Type 18–8, greatly reduce the decompn. rate of H_2O_2 and in this condition, the latter is not decompd. more rapidly than by Al. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 2539.) (W)

SORPTION ON COTTON FIBRES OF DYES WITH VARYING MOLECULAR ASSOCIATION IN SOLUTION. G. L. Clark and Julia Southard. *Physics*, 1934, V. 5, P. 95–100.

As a concd. soln. of oxazine dye (Nile blue sulfate) or of methylene blue is dild., the predominant mol. species alters by steps in complexity (cf. *Chem. Abs.*, V. 25, P. 3223). This property permits a study of cotton fibre pore structure and size by measuring sorption as function of concn. The amt. of sorption was detd. by spectrophotometric measurements *on the solns.* before and after sorption of the dye to equil. on known wts. of cotton. X-ray diffraction studies of cotton with sorbed dye showed no alteration of cellulose pattern. A large increase in dye sorption naturally accompanies change from micellar to mol. dimensions, compatible with predominating cotton pore sizes. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3237.) (W)

STRENGTH MEASUREMENTS ON RAYON CREPE YARNS BEFORE AND AFTER BOILING. A NEW METHOD OF TESTING CREPE YARNS. W. Weltzien and W. Königs. *Mitt. Textilforschungsanst. Krefeld*, 1932, V. 8, P. 67–9.

It is recommended to det. the breaking load of rayon crepe yarns both before and after soaking overnight in 1% soap and then heating at 80–90° for one hr., washing and drying. This treatment often causes a marked fall in strength, but is less severe than most dyeing processes. The strength of the soaped yarn should not be less than 1.1 g. per denier, and if it is < 1 g. per denier faults are likely. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3239.) (W)

SULFUR DYES: COLORIMETRIC DETERMINATION OF. G. E. Levant and R. I. Nemtzova. *J. Applied Chem.* (U. S. S. R.), 1933, V. 6, P. 546–51.

The dye to be tested and a standard are oxidized with H_2O_2 and compared in a colorimeter. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 2909.) (W)

TEXTILE FINISHES RESEARCH. H. P. Stevens and R. Gaunt. *Bull. Rubber Growers' Assoc.*, 1933, V. 15, P. 653–66.

The object of the investigation was to find a means of utilizing latex or rubber dispersions in sizes for calico printing, dyeing and stiffening. Addn. of latex to starch-clay-olein sizes made the finish less easily removed by washing. The technic used by Hauser and Hünemörder in studying the penetration of threads by latex (cf. *Chem. Abs.*, V. 27, P. 2600, 6015) was unsatisfactory, and a new better method is to soak thread in latex, dry, stain with boiling satd. alc. Sudan III, dry, embed in a paraffin wax-stearic acid mixt., cut and mount in glycerol jelly. Without a wetting agent, there was almost no penetration, but with all com. wetting agents tested, there was complete impregnation of the threads (not of each fibre). Neither preliminary swelling of the fibres nor surface xanthation aided penetration. C_6H_6 solns. of rubber penetrated the threads but not into the fibres. Treatment with latex of cloth for showerproofing gave insufficient protection for practical utility, except with a coating made from chlorinated rubber in C_6H_6. Data show the water absorption of cloth treated with latex. Various types of substances were ineffective in overcoming the tackiness of latex-treated cloth, as was preliminary dialysis of the latex, but pro-

longed immersion in hot water was successful, though the product had an increased capacity for water absorption. There is preferential absorption by cloth of the serum, *i.e.*, of the components, so that the dried product contains a disproportionately high quantity of non-rubber substances, which in turn probably account for the tackiness. This may be prevented by squeezing wet. Dyeing expts. led to uncertain results. Addn. of vulcanizing agents to the latex before impregnation and heating of the impregnated fabric overcame tackiness by the formation of a vulcanized impregnation. Expts. aimed at the use of latex in a variety of com. products are described briefly, *e.g.*, the impregnation of stockinette with latex, in which case the product has phys. properties of promise for bandages, etc. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 2568.) (W)

WOOL: LOADING OF. L. Armand. *Tiba*, 1934, V. 12, P. 83–9.

A brief review. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3237.) (W)

IV. RESEARCH METHODS AND APPARATUS

IODINE NUMBER OF WOOL: A METHOD FOR DETERMINING THE ACTION OF VARIOUS CHEMICAL REAGENTS ON WOOL AND OTHER PROTEINS. Milton Harris, Harvey A. Neville and William C. Fritz. *B. S. J. Rsch.*, June, 1934, P. 803–9.

"The purpose of this research was to find a method for determining the action of various chemical reagents upon wool. The iodine number provides a qualitative measure of the extent to which the amino groups are affected by various treatments of the protein. Amino acids and proteins exhibit iodine numbers as determined by the standard method. The iodine numbers of such substances do not indicate ordinary unsaturation but are shown to be related to the free amino nitrogen content. The iodine numbers of some typical proteins are reported and a general correspondence between the iodine numbers and the isoelectric points of the proteins is shown.

"Conversion of amino groups to hydroxyl groups, combination of amino groups with strong acids, and other chemical reactions which affect the amino groups reduce the iodine numbers of amino acids (with the exception of cysteine) to zero. Part of the iodine number of wool is shown to de due to cysteine which is very susceptible to oxidation. The iodine number of wool is therefore affected by reactions of chemical reagents with the amino or the cysteine groups. This method will distinguish, for example, between reversibly adsorbed and chemically combined acid. The latter can be removed by the action of an alkali and this restores the original iodine number of the wool." (C)

HUMIDITY: MEASUREMENT OF THE—OF THE AIR IN CLOSED SPACES. *Tex. Mfr.*, Jan. 1934, P. 17–18.

An abstract of a report issued by the Department of Scientific and Industrial Research (Great Britain). The material published through H. M. Stationery Office deals mainly with three methods, wet-and-dry bulb hygrometer in its various forms, the dew point apparatus and the hair hygrometer. A new table of relative humidities at dry bulb readings from 30 to 100 C. with the corresponding depression of the wet bulb is given. (S)

LINSEED OIL SIZES. I. GENERAL METHODS FOR THE INVESTIGATION OF DIFFICULTIES AND FAULTS. W. Weltzien. *Mitt. Textilforschungsanst. Krefeld*, 1932, V. 8, P. 1–5.

In removing linseed oil size from rayon it is better to soap at 80° than at 95–100°. Residues of size can often be detected by fluorescence in ultraviolet light, by treatment with aq. Na_2S, or by dyeing with methyl violet (acetate rayon), but none of these methods is certain and they should be applied to the material both before and after a desizing treatment. The best method is microscopical examn. of the filaments. Damage by linseed oil size most often occurs in bleached material, it is found in places where the size is abnormally acid, and it is often due to traces of metals. Size can be tested by heating sized material at 105° for 2 hrs., when little loss of strength should occur. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 2191.) (W)

RAYON: TESTING OF. W. B. Sellars. *Am. Dye. Rptr.*, March 26, 1934, P. 164–168.

A brief paper purporting to be a resumé of the methods in current use by the rayon manufacturer in testing and controlling the uniformity of the product. Treatment is superficial and certain of the tests, notably that for friction coefficient are open to question. (S)

TELECOLOR MACHINE: DEMONSTRATION OF THE. C. Earl Hayes. *Am. Dye. Rptr.*, Feb. 26, 1934, P. 124–126.

A very general and incomplete discussion of the photoelectric cell for color matching. No details of the instrument are given other than that it involves photoelectric cells and the use of filters. (S)

TEXTILE MICROSCOPY ADVANCES. Edward R. Schwarz. *Am. Dye. Rptr.*, March 12, 1934, P. 141–144.

An abstract of a paper presented before the Northern New England Section of the A. A. T. C. C., Jan. 1934. Mention is made of the use of motion picture photography in connection with textile studies with the microscope together with methods of attack of problems of fundamental fibre structure. (S)

WETTING PROPERTIES OF LIQUIDS: DETERMINING THE. M. D. Rozenbroek. *Mell. Textilber.*, 1933, V. 14, P. 306–7.

Constructional details are given of an app. which comprises a long and narrow liquor trough (*A*) and an arrangement whereby two standard lenghts of right-and left-hand, hard-twisted cotton yarns are extended horizonally (similar to two consecutive links in a chain) between a fixed stop and the lower end of a pivoted needle, the upper end of which moves over a graduated dial. The wetting power of a liquid is detd. by raising *A* until the yarn is submerged and noting the rate of contraction of the yarn. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 3240.) (W)

Book Review

MANAGING CLOTH INVENTORIES IN THE COTTON TEXTILE INDUSTRY. Dr. John J. Madigan. Business Research Studies, No. 6. Division of Research, Harvard Graduate School of Business Administration. Pp. 53, Price $1.00.

Presents a critical examination of the inventory policies and methods of control among grey goods mills and producers and converters of finished cloth. Four chapters of the study are devoted to the inventory problems of finished and converted fabrics. One shows how to estimate deliveries which are the basis for establishing inventory limits and production schedules. Two chapters discuss the desirable size of inventory and consider how it is influenced by production and distribution policies. The application of the principles of control is included in a chapter which develops such details as (1) item control and analysis of slow-moving stock and (2) the over-all control of total inventory. A final section considers organization for inventory control.

Dr. Madigan's study is complementary to a report on "Merchandising of Cotton Textiles" prepared by Professors M. T. Copeland and E. P. Learned for the Textile Foundation last year. Dr. Copeland in commenting on Dr. Madigan's study says: "The improvement which has recently taken place in conditions in the cotton textile industry cannot be assumed to promise relief from serious inventory problems in the future. On the contrary, it is reasonable to assume that inventory risks will continue to perplex cotton mill executives. It is with the basic questions involved in these inventory risks that Dr. Madigan deals in this study." (C.)

(*Continued from page 479.*)

ginned aids in providing large supplies of pure seed. Many single-variety communities have been organized during the past several years and the number is increasing as the practical advantages are becoming better recognized. In order to insure the agricultural as well as the textile value of the varieties selected for community planting, it is necessary to have adequate experimental data on the varieties before they are recommended.

"The State Experiment stations throughout the Cotton Belt have tested varieties in various localities for many years. The current trials being aided by the Textile Foundation will incidentally provide some supplemental information along this line. Their primary purpose, however, is to supply data on the broader, regional adaptation of varieties, to help delimit the areas where one class of varieties should give way to another, and to supply basic information on the effect of change in environment on different varieties of cotton grown under the same plan. In addition to yield and other agronomic data, the Bureau of Agricultural Economics of the U. S. Department of Agriculture will co-operate in making comprehensive laboratory and experimental mill studies of the fibre from samples of known variety and production history. These should provide a valuable basis for further studies of the roles of inheritance and environment in determining fibre quality."